"Electric toy vehicle with improved grip"

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DESCRIPTION

The present invention relates to the sector of electric toy vehicles which are typically intended for transporting children while playing. In particular, the present invention concerns an electric vehicle which has numerous advantages owing to improved grip of the driving wheels on the rolling surface.

For some years various electric toy vehicles which reproduce, on a small scale, cars, motorcycles, scooters or the like, have been known. These known vehicles comprise at least two wheels, a seat (or saddle, in the case of scooters and motorcycles) and a metal or plastic frame.

The vehicles present on the market essentially consist of three types. The first type is a single-speed vehicle composed of: two or more blown high-density polyethylene (HDPE) wheels; an electric motor; a reducer; a wiring system; and a 6 V power supply battery. The second type is a vehicle with more than one speed, composed of two or more blown HDPE wheels; two motors, two corresponding reducers; a wiring system; a 12 V power supply battery; and a thermal resistance for reducing the speed and for preventing possible overloads. The third type is a vehicle with more than one speed composed of two or more blown HDPE wheels; two motors; two reducers; a wiring system; two 6 V batteries; a commutator for connecting the batteries in series or in parallel in order to control the speed; and a system for controlling the overload by means of inductance.

It is known that models with more than two driving wheels, for which a corresponding number of motors/reducers are used, are available on the market.

The Applicant has realized that the electric toy vehicles of the known type have various drawbacks and limitations.

As regards two-speed vehicles, it is pointed out that, in vehicles of the second type, which are equipped with a 12 V battery, the speed is controlled by a thermal resistance which results in wastage of power. In vehicles of the third type, however, the speed is controlled by a commutator which allows the two batteries to be used, depending on the speed set, at 6 V or 12 V. It follows that the actual power consumption is strictly related to the operating speed. It must also be pointed out that, if, in the vehicles of the second type, there is a limited operational autonomy precisely because of the management system used, in the vehicles of the third type the solution used to solve the same problem results in increased costs owing to the use of two batteries and a more complex wiring system.

The Applicant has established that the known electric toy vehicles have poor or even zero grip when the vehicle is placed on surfaces which are substantially smooth (for example marble floors, tiled floors, etc.), on moist surfaces (grass lawns) or the like. As a result, the known vehicles, from the standing position, start with extreme difficulty and in any case struggle to keep to the steering path imposed by the driver.

The Applicant has also noted that the wheels of the known vehicles, which are made of internally hollow rigid plastic act like a sound box and amplify the noise during movement of the vehicle, in particular in closed surroundings. As a result, the use of the electric toy vehicle is particularly noisy, in particular in surroundings which are substantially closed or in any case confined.

Moreover, the Applicant has found that the wheels of the vehicle, which are substantially rigid, transmit jerks and jolts when passing over rough ground and greatly limit the comfort on-board.

In addition, the traction obtained with the use of a single motor and with the wheels currently used results in various difficulties. Moreover,

a high power consumption and rapid and non-uniform wear of the wheels occurs.

Any attempt to overcome the abovementioned problems with the use of several motors, several reducers and several batteries achieves improvements but at the same time results in a reduction in the operational autonomy and an increase in the cost of the product. The problem of grip is amplified if the traction of the vehicle is obtained by using two motors since, when the vehicle performs a turning movement, one of the two motors suffers a braking action due to the friction. As a result, the vehicle loses its residual adherence, does not keep to the steering path and the radius of curvature increases. This results in a limited possibility of using the vehicle in unsuitable surroundings as well as a difficulty in reversing the direction of travel. Therefore, if, as usually occurs, the known vehicles are used in confined spaces, they are affected not only by premature wear of the wheels, but in particular of the motors and the batteries which are subject to the stress resulting from continuous braking and from the need for continuous changes in direction.

Paradoxically, when the basic structure of the rolling surface is able to offer good adherence (for example, soft rubber surfaces, carpets or the like) the starting up and stopping operations in the case of a known vehicle are excessively sudden, violent and "unpredictable". In fact, power is supplied (or interrupted) suddenly (compared to poor grip situations where the wheels tend to spin) and the driver is unprepared for these sudden acceleration or deceleration situations. For this reason, the driver runs the risk of suffering knocks against parts of the vehicle, in particular against the dashboard and the steering wheel, and of suffering bruising.

The Applicant has noted the abovementioned limitations and has set themselves the object of providing an improved electric toy vehicle

which is safer and more comfortable compared to the present vehicles of the same type, while maintaining low costs (even lower than those of the present vehicles).

These and other objects are obtained by an electric toy vehicle having the characteristic features described in Claim 1 and by a system for controlling an electric toy vehicle according to Claim 20. The dependent claims specify further advantageous characteristic features of the invention. All the claims are considered to form an integral part of the present description.

According to a first aspect, the present invention relates to an electric toy vehicle comprising: an electric motor, a speed reducer, a power supply battery for powering said electric motor and moving the vehicle, and at least two wheels, at least one of which is a driving wheel, characterized in that at least one of the wheels has a coefficient of friction greater than about 0.35, preferably greater than about 0.5 and even more preferably ranging between about 0.5 and about 3.0.

Conveniently, said at least one wheel having a coefficient of friction greater than about 0.35, preferably greater than about 0.5 and even more preferably ranging between about 0.5 and about 3.0 is a driving wheel.

Preferably, said at least one wheel having a coefficient of friction greater than about 0.35, preferably greater than about 0.5 and even more preferably ranging between about 0.5 and about 3.0 comprises a rim and a tyre, where said tyre is a tyre comprising a rubber carcass.

Conveniently, said rubber carcass comprises two cross plies.

Preferably, said cross plies comprise cords made of nylon or the like.

Preferably, said tyre comprises a tread with a raised pattern.

Preferably, the thickness of the carcass in the sidewall zone ranges between about 1.0 mm and 4.5 mm, more preferably between about 2.0 mm and 3.8 mm, and even more preferably between about 2.5 mm

and about 3.3 mm.

According to an advantageous embodiment, said tyre has a size, expressed in inches, of 10.00 X 5.00 – 5"1/2 (corresponding, in mm, to 260 X 120 – 5"1-2). According to a further embodiment, said tyre has a size, expressed in inches, of 13 X 6.00 – 7" (corresponding, in mm, to 330 X 150 – 7"). According to yet another embodiment, said tyre has a size, expressed in inches, of 15 X 7.00 – 8"1/2 (corresponding, in mm, to 380 X 180 – 8"1/2).

Preferably, said at least one wheel having a coefficient of friction greater than about 0.35, preferably greater than about 0.5 and even more preferably ranging between about 0.5 and about 3.0 comprises an inner tube and an associated valve.

According to one embodiment, said vehicle comprises an electronic control system, which is typically an electronic board, designed to regulate the power supply voltage to the motor, for example by means of a potentiometer or a similar device.

Conveniently, said electronic control system also comprises means for regulating the acceleration in a predetermined manner substantially independently of the load transported by the vehicle, in accordance with a suitable acceleration ramp.

Conveniently, said electronic control system also comprises means for regulating the deceleration in a predetermined manner substantially independently of the load transported by the vehicle, in accordance with a suitable deceleration ramp.

Conveniently, said electronic control system also comprises short-circuiting means for managing the motor braking function.

Conveniently, said electronic control also comprises means for controlling the direct current flow and preventing current peaks affecting the motor, for example when starting and reversing.

Conveniently, said electronic control system also comprises means

able to disable the functions of the vehicle at predefined overload values, so as to avoid, for example, unsuccessful attempts by a vehicle to overcome an obstacle, for example a wall.

Conveniently, said electronic control system also comprises means for limiting complete discharging of the power supply battery.

Conveniently, said electronic control system also comprises means for electronically disabling the functions of the vehicle during recharging of the battery.

Conveniently, said electronic control system also comprises means for indicating the state of charging of the battery, for example by means of a display or the like.

The solution adopted allows the optimum use of the vehicle resources as well as maximum use in terms of operating autonomy, such that the wiring system uses, for power functions, wires with a cross-section of about 2.5 mm^2, while for the signalling functions the cross-section of the wires is reduced to about 0.5 mm^2.

The present invention will certainly become clear from the detailed description which follows, provided by way of a non-limiting example, to be read with reference to the accompanying illustrative plates of drawings, in which:

- Figure 1 shows the layout of the transmission of an electric toy vehicle of the first known type, having one speed;
- Figure 2 shows the layout of the transmission of an electric toy vehicle of the second known type with more than one speed;
- Figure 3 shows the layout of the transmission of an electric toy vehicle of the third type with more than one speed;
- Figure 4 shows a layout of the transmission of an electric toy vehicle according to the present invention;
- Figures 5a and 5b show cross-sections through a tyre according to the present invention and a known tyre for agricultural use;

- Figure 6 shows schematically an electronic control system according to the present invention.

The same reference numbers will be used to indicate the same parts or components which are functionally equivalent.

Figures 1, 2 and 3 show three layouts of the transmissions of respective electric toy vehicle of the known type. The first layout is generally used in toy vehicles which are recommended for little children. The second and the third layouts are generally used in toy vehicles which allow transportation of one or more passengers. It is useful to clarify henceforth that the term "electric toy vehicle" (or equivalent terms) shall be understood in this connection as referring to any vehicle with two, three or four (or more) wheels, which is powered by direct current at 6 V (or 12 or 24 V), recommended (depending on the models and the drive system) for children having an age of between about two years and ten years.

The layout according to Figure 1 provides for a motor 1 which is powered by a (6 V) battery 2 and a speed reducer 3 (shown in an exploded view) which is connected to a wheel 4 (driving wheel). The wheels 4 and 5 are both made of HDPE and have a coefficient of friction, at room temperature, ranging between 0.08 and 0.2 measured in accordance with the Standard ASTM D1894 *"Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting"* . The layout according to Figure 1 also shows a pedal-operated switch P and a device 1 for reversing the direction of travel.

The layout according to Figure 2 provides for two motors 1, which are powered by a single (12 V) battery 2, and two corresponding speed reducers 3 (shown in an exploded view) which are connected to respective wheels 4 and 5. The wheels 4 and 5 are made of HDPE and have a coefficient of friction, at room temperature, ranging between 0.08 and 0.2 measured in accordance with the Standard ASTM D1894.

The layout according to Figure 2 also shows a pedal-operated switch P, a device I for reversing the direction of travel and a selector for changing gear.

The layout according to Figure 3 provides for two motors 1 which are powered by two respective (6 V) batteries 2 and two corresponding speed reducers 3 (the right-hand one shown in an exploded view) connected to respective wheels 4 and 5. The wheels 4 and 5 are made of HDPE and have a coefficient of friction, at room temperature, ranging between 0.08 and 0.2 measured in accordance with the Standard ASTM D1894. The layout according to Figure 2 also illustrates a pedal-operated switch P, a device I for reversing the direction of travel and a selector M for changing gear. The selector M also comprises a commutator for connecting the batteries in series or parallel in order to control the speed. The layout according to Figure 3 also comprises a device 6 for controlling the overload by means of inductance.

The layouts according to Figures 1, 2 and 3 all have the problems and the limitations listed in the introductory part of the present description.

A layout of the transmission of an electric toy vehicle according to the present invention is shown in Figure 4.

The layout according to the present invention comprises an electric motor 11, a (12 V) battery 12 for powering the motor 11 and a speed reducer 13 which transmits the movement to a wheel 14. Unlike the known layouts, at least the wheel 14 connected to the speed reducer (but preferably also the other wheels 15 of the vehicle) is substantially soft and has a coefficient of friction greater than about 0.35, preferably greater than about 0.5 and even more preferably ranging between about 0.5 and about 3.0. Depending on the specific use of the vehicle, the coefficient of friction may, in particular, range between about 0.5

and 1.0, between about 1.0 and 1.5, between about 1.5 and 2.0, between about 2.0 and 2.5 or between 2.5 and 3.0. Tyres with coefficients of friction greater than 3.0 are also possible, in particular when it is envisaged using the vehicle on particularly smooth and slippery surfaces.

Figure 5a illustrates, by way of example, a cross-section through an embodiment of a tyre 141 of a wheel 14 according to the present invention. The tyre 5a has a size 10 X 5.00 – 5"1/2 (corresponding, in mm, to 260 X 120 – 5"1/2). The first number indicated represents the outer diameter, the second number represents the cross-section and the third number represents the fitting diameter generally always expressed in inches. Figure 5b instead shows a cross-section through a tyre available on the market for agricultural use. The tyre according to Figure 5b is produced under the trade name "DURO" and has a size of 11 X 4.00 – 5". The tyre 141 according to the present invention comprises a carcass and two sidewalls which terminate in respective beads. Preferably, the tyre also comprises a tread with radially projecting blocks and grooves for a greater grip of the vehicle. The carcass is formed by two cord cross plies. Preferably the cords are textile or nylon cords arranged with a density comparable to that of a bicycle tyre or the like. Figures 5a and 5b shows some significant dimensions of the two tyres compared. In particular, the carcass thickness of the tyre according to Figure 5a along the sidewalls is about 3 mm, while that of Figure 5b is about 7 mm.

The recorded weight of the known tyre (Figure 5b) is about 1.875 kg, while the weight of the tyre according to the invention (Figure 5a) is less than half and equal to about 0.85 kg. Therefore, the comparison has shown how a tyre which equips a vehicle according to the present invention is much lighter and more economical than a similar known tyre for agricultural use. The characteristic feature of lightness is very

important since an electric toy vehicle must be light in order to have acceptable performance features and limit the wear of the motor and consumption of power by the battery. The characteristic feature of economy is also very important in vehicles of this type and is due mainly to the saving of rubber material (reduced thickness of carcass) and to the consequent shorter vulcanization times.

According to a preferred embodiment, each tyre 141, 151 is mounted on a rim 143, 153, for example made of plastic, composite material or metal, with an inner tube (not shown). According to an alternative embodiment, the tyre 141, 151 is of the tubeless type, i.e. without an inner tube. This second embodiment requires a greater precision in machining of the rim and is therefore less preferred.

The fact of having equipped the vehicle with a driving wheel having a coefficient of friction greater than about 0.35, preferably greater than about 0.5 and even more preferably ranging between about 0.5 and about 3.0 has enabled substantially all the problems of the known art indicated above to be overcome. Firstly, a vehicle according to the invention is easier to start from standstill and easier to keep along the steering path of the driver. It has also solved the problems associated with the noise of the wheels on the rolling surfaces. Moreover, the travel comfort is much improved owing to the softness of the tyres compared to the rigid wheels of the known vehicles.

The wear of the tyres is practically negligible and in any case substantially uniform also without using two separate motors.

According to a particularly advantageous embodiment, the motor 11 is managed by means of a special control system 17.

The fact of using a single electronically managed motor, associated with tyres having a coefficient of friction greater than about 0.35, preferably greater than about 0.5 and even more preferably ranging between about 0.5 and about 3.0 greatly improves the drivability of the

vehicle and allows use thereof also in relatively confined spaces. The Applicant, in fact, has noted a significant reduction in the minimum steering radius compared to the known electric toy vehicles, namely from about 2.0-3.0 m (for a known four-wheel vehicle) to about 0.5-1.5 m (for a similar vehicle according to the invention).

According to a first aspect, the control system 17 is able to regulate the power supply voltage to the motor and therefore the speed of the vehicle. The electronic control system 17 preferably consists of an electronic power and signalling board.

As shown schematically in Figure 4, the control system 17 co-operates with one or more of the following devices: a pedal-type switch P, a key-operated switch C, a device I for reverse travel, a selector M for changing gear M; an acoustic device A (horn or the like); a display VB for charging the battery; one or more illumination lamps (front LH "LA_SX", front RH "LA_DX", rear LH "LP_SX" and rear RH "LP_DX"); and a socket 182 for recharging the battery. Conveniently, the electronic control system 17 is programmed so that the motor receives predetermined fractions of the maximum voltage which can be supplied by the battery. For example, if the maximum voltage which can be supplied by the battery is 12V, the electronic control system may be programmed so as to supply to the motor a first fraction of 3 V, a second fraction of 6 V, a third fraction of 9 V or the whole voltage of 12 V.

The supplying of these voltage fractions may be controlled by the driver (child), may be factory-set, may be determined by an adult or may be a combination of the abovementioned options. In the first case, the child will have access to a speed selector and will be free to choose the speed which is most suited to the circumstances. In the second case, it will be the manufacturer who determines the maximum speed for each type or category of vehicle (this means that, while maintaining

the same components, it is possible to construct electric toy vehicles for children who are less expert or for older children). Alternatively, the setting is left to an adult, providing a first selector in a zone which is inaccessible for the child and, if necessary, a second selector which can be operated by the child/driver. This solution is advantageous because it allows an adult to set the maximum permitted speed of the vehicle depending on the age and the actual abilities of the child.

Preferably, said electronic control system 17 is programmed so as to provide a predetermined acceleration ramp 171 independent of the load transported by the vehicle. Figure 6 shows an embodiment of an acceleration ramp 171 and deceleration ramp 172. Figure 6 also shows a reversing travel ramp 173. According to the present invention, the maximum speed of the electric toy vehicle (of the order of 8-10 km/h) is reached after a certain time interval (of the order of 3-4 seconds). According to the ramp shown in Figure 6, the acceleration of an electric toy vehicle starting in 4th gear (selector in position 4) is the same as a vehicle which starts in 1st, 2nd or 3rd gear; the difference lies in the maximum speed which can be reached without making further gear changes. The same concept applies to the deceleration phase.

In any case, the acceleration or the deceleration of the vehicle according to the present invention is independent of the load transported. This solves a very common problem in the known electric toy vehicles where the smaller the weight (i.e. a younger and hence more inexpert child) the greater the acceleration and the greater the whiplash effect affecting the vehicle and hence the driver of the vehicle.

Moreover the motor braking effect provided by the electronic control system combined with the grip of the tyre according to the invention favours the stoppage of the vehicle without causing a sensation of discomfort for the driver which is implicit in known vehicles since the stoppage occurs in a controlled, predictable and safe manner.

Moreover the electronic control system allows control of the voltage supplied by the battery to the motor during the starting movement and reversing, preventing the motor being subject to uncontrolled electric discharges (sparks between brushes and slip rings which cause motor wear) and the battery having a shorter life owing to the consequent stress.

Moreover, the electronic board fixes overload values of the motor (for examples vehicles against an obstacle), protecting it from the stress due to unnecessary operation during a standing start and wear of the wheels which are forced to spin.

According to a preferred embodiment, the electronic control system 17 provides a closed-loop speed electronic control which, irrespective of the payload, keeps constant a pre-established speed in any travel condition such as on flat ground, during ascents or descents. According to the present invention, a sensor detects the number of wheel turns and conveys such a detected number of turns to the board. The board compares a set speed with the detected speed and it supplies: a) more energy if the comparison results in a negative value (ascent); or b) less energy if the comparison results in a positive value (descent).

In case the requested energy is less than zero, (the vehicle is driving along a steep descent), the motor acts as energy generator and it inverts the flow. This effect is used so that the motor is electronically bypassed (see connection 19) and it acts as exhaust brake.

This results in a safer vehicle (exhaust brake during steep descents) and in a more effective energy management (the power consumption becomes strictly dependent on the type of travelled ground).

In order to regulate different speeds of the vehicle, an electronic-type magnetic selector is provided, said selector being stepwise and it is preferably regulated by a mechanical switch arrangement. The mechanical switch arrangement is preferably provided on the gear lever

(for toy car vehicles) or hand grip (for toy motorcycles or scooters) for setting the gear. The speed is regulated through a magnetic sensor which, once the position of the gear lever (or hand grip) has been detected, communicates it to the electronic board. The electronic system regulates the maximum speed set according to the gear selected by the user.

Moreover, the electronic control system predefines (174) a maximum limit of use of the battery in order to prevent complete discharging thereof. This is not to the detriment of the vehicle's autonomy, since the vehicle loses only an insignificant part of its autonomy in this connection. As a result, since the battery cannot become completely discharged, it may be fully recharged, something which otherwise would not be possible, and the operating life of the battery is also increased about three or four times compared to that which occurs in known vehicles. The above does not increase the consumption of electric power by the battery which, in the layout adopted according to the present invention, is relatively low and allows a greater degree of autonomy to be obtained compared that which is achieved with the known layouts involving two motors.

Moreover, operation of the vehicle during recharging of the battery may be disabled electronically as a result of the electronic control system 17 (for example by means of simple introduction of a jack 181 of a battery charger 18) and not mechanically (as occurs in the known vehicles), allowing the user to perform the necessary recharging operations in absolute safety and very simply. On the other hand, in the known vehicles, it was required to disconnect the terminals of the battery in order to prevent a child attempting to use the vehicle during recharging of the battery. The operation was laborious, awkward and time-consuming also because it was required to remove the seat or the saddle in order to gain access to the battery compartment.